(12) UK Patent Application (19) GB (11) 2 239 366 (13) A

(43) Date of A publication 26.06.1991

(21) Application No 8825706.8

(22) Date of filing 03.11.1988

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(51) INT CL[5]
G01S 5/16

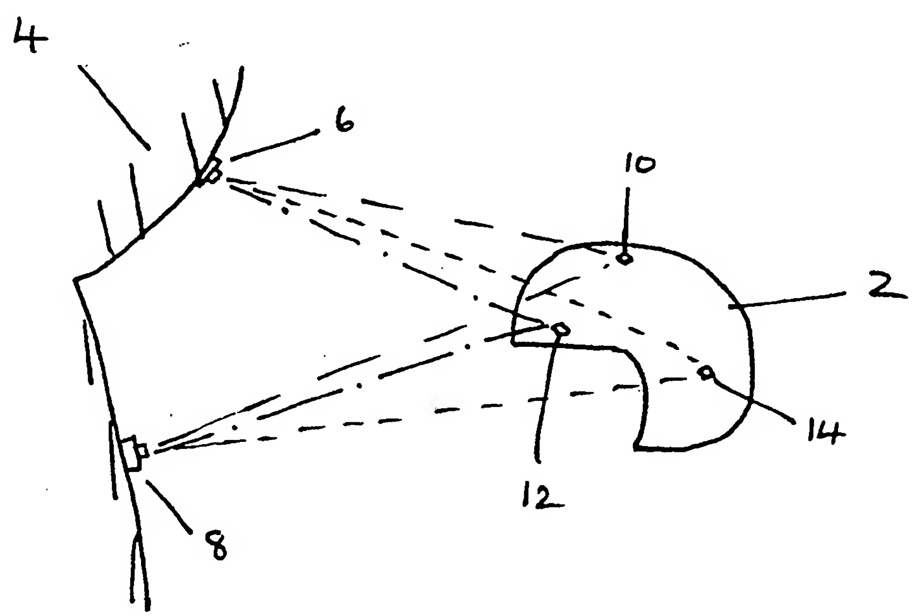
(52) UK CL (Edition K)
H4D DLPC DLPX D775 D782

(56) Documents cited
GB 2002986 A

(58) Field of search
UK CL (Edition K) H4D
INT CL[5] G01S

(54) Helmet pointing apparatus

(57) A helmet pointing apparatus enabling a pilots line of sight to be determined relative to a fixed coordinate system within a cockpit comprises at least 3 LED light sources 10, 12, 14 mounted on the helmet 2 and at least 2 direction-of-arrival optical sensors 6, 8 mounted fixedly in the cockpit. The direction of arrival of the light from the sources to the sensors can be employed to compute the orientation of the helmet. The sensors are of a "mirror-cube" type.



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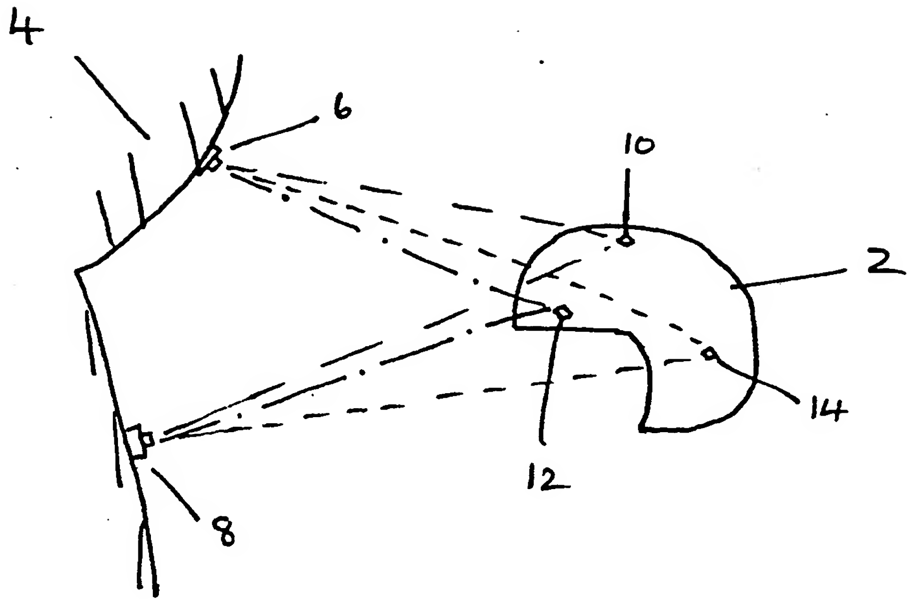

HELMET POINTING APPARATUS

This invention relates to an apparatus for determining the line of sight and optionally orientation in space of a helmet and particularly, but not exclusively, to helmets as worn by military personnel.

Military helmet pointing systems are known, and represent an alternative solution to the aiming of guns or missiles. For example, the traditional method for a fighterpilot to aim a missile at a desired target relies on the pilot aligning the aircraft generally in the direction of the target by use of an aiming graticule displayed in front of him; this is known as boresight aiming. With a helmet pointing system, the pilot merely looks in the direction of the target (which could be off-axis in relation to the aircraft direction), aided by an aiming graticule on, for instance, the helmet visor. A sensing system is provided in the cockpit for determining the line of sight and optionally the orientation in space of the helmet, and for computing the geometrical relationship between the helmet line of sight axis and the missile longitudinal axis. The latter is typically the same as the aircraft longitudinal axis when the missile waits to be fired. The off-axis relationship is passed to the guidance system of the missile, which then has the necessary information for heading in the direction of the off-axis target when fired. Such helmet pointing systems can be similarly used for controlling gun aiming (e.g. in helicopters or tanks) or even in non-military environments. One example of the latter would be the use of such a helmet in crowd control: the direction of pointing of a remotely-controlled camera could be commanded by an operator wearing such a helmet and viewing the crowd from an environment which was equipped with the necessary optics and electronics.

One known helmet pointing system relies on the

transmission of electromagnetic field vectors from a fixed antenna to a receiving antenna on the helmet. The transmitted electromagnetic field provides a fixed reference in space, and as the helmet moves in the field the receiving antenna provides signals to a sensing unit which is able to compute the helmet orientation relative to the fixed field. Such systems are described in, for example, US-A-4 287 809 and 4 394 831. A disadvantage of systems based on electromagnetism is that they are susceptible to unwanted influence from other magnetic fields in the environment (e.g. in the aircraft cockpit).

With any helmet pointing system for use by a pilot, one difficulty is sampling the data relating to helmet position fast enough bearing in mind that the pilot's head is sometimes moving at a rate greater than 100° per second. Unless the system is capable of rapid resampling, helmet position errors will be introduced. The present invention relates to a helmet pointing system which enables the data to be sampled rapidly and with an accuracy suitable for use in the cockpit of, say, fighter aircraft.

According to the invention, there is provided a helmet pointing apparatus which comprises a first plurality of light sources, a second plurality of direction-of-arrival sensors each for receiving a beam of light from the said light sources, either the first plurality or the second plurality being fixed to a helmet whose line of sight and, optionally, orientation it is desired to compute, and the other of said pluralities being fixed at fixed reference points, and means responsive to signals received by said direction-of-arrival sensors for relating each respective signal to specific light sources, for computing the direction-of-arrival from any given sensor to any given light source, and for computing line-of-sight signals and

optionally orientation signals with respect to the fixed reference points for said helmet.

Direction-of-arrival sensors (DOAS) are commercially available and these may be used in the invention. One known DOAS is termed a quadrant detector and consists of four planar photodetectors, one each disposed in the four quadrants of a plane about imaginary X-Y axes. Any beam of light striking the detectors is first focussed by a lens. The actual direction of arrival of the light beam determines precisely where, upon the four quadrants, the focussed beam strikes. The relative conduction of the four photodetectors can then be translated into a geometrical direction of arrival. Such a device is available from Integrated Photomatrix Ltd., Dorchester, UK (part IPL 10130) and has a focussed light spot about 1 mm in diameter.

A further DOAS replaces the four quadrant photodetectors with a CCD array. Again, depending upon where the focussed beam strikes the array, the received signal can be translated into a direction of arrival. A suitable CCD array is a Sony ICX021CL, which is a solid state image device designed for black/white TV. It has a focussed light spot about 20 μm in diameter.

Preferable, however, the present invention employs DOAS of the type described and claimed in our copending patent application of even date entitled "Optical Sensor". Most preferably each DOAS is of the "mirror-cube" type specifically described in said patent application. A copy of the specification of the latter application is attached for reference. An advantage of the "mirror-cube" type DOAS is that it can be manufactured in miniature format to give high accuracy, repeatability and sensitivity within the close confines of a pilot's cockpit.

Preferred features of the invention will now be

described, by way of example, with reference to the accompanying drawing, which illustrates schematically a preferred form of the invention as employed in the cockpit of an aircraft.

Referring to the drawing, a pilot's helmet 2 is shown disposed within the cockpit 4. The cockpit carries at least 2 DOAS 6,8 of the "mirror-cube" type already described. On the helmet is mounted at least 3 LED (light-emitting diode) light sources 10,12,14.

The LEDs emit spherical light waves which are sensed by the DOAS. The size of the DOAS relative to their distance from the LEDs is arranged to be sufficiently small that, for practical purposes, each DOAS can be considered to receive planar light waves from each LED.

The helmet is independent of the remainder of the system and includes a battery power supply for the LEDs and for oscillators to tone modulate each LED at different frequencies. The DOAS receive the tone modulated light signals and discriminate between each LED by filtering the received signals. From each discriminated signal the direction of arrival of the light beam (i.e. the direction in space from the DOAS to the LED in question) may be computed as described in the said copending patent application.

In a perfect system, the position in space of any one LED ought to be defined by the intersection of the computed directions-of-arrival from two spaced-apart DOAS to the LED. In practice, these lines may not exactly coincide and it is convenient to choose, as the LED position, the midpoint of the shortest line segment which joins two computed lines. With the positions in space of three separate LEDs having been determined, it is then a simply trigonometric matter to translate these positions into the orientation of the helmet in space, and to the pilot's line of sight.

For greater accuracy, a larger number of DOAS and LEDs may be employed. It is also possible to reverse the positions of the LEDs and DOAS - so that the latter are upon the helmet. This is less practical as it is likely to necessitate connecting the helmet to the aircraft's electronic systems.

With the apparatus of the invention it is possible to determine not only the line of sight of the pilot relative to the cockpit, but also the orientation of his head about this line-of-sight. This latter information may, in fact, not be necessary if, for example, the line of sight is to be employed to fire a missile upon an off-aircraft-axis trajectory.

CLAIMS:-

1. A helmet pointing apparatus which comprises a first plurality of light sources, a second plurality of direction-of-arrival sensors each for receiving a beam of light from the said light sources, either the first plurality or the second plurality being fixed to a helmet whose line of sight and, optionally, orientation it is desired to compute, and the other of said pluralities being fixed at fixed reference points, and means responsive to signals received by said direction-of-arrival sensors for relating each respective signal to specific light sources, for computing the direction-of-arrival from any given sensor to any given light source, and for computing line-of-sight signals and optionally orientation signals with respect to the fixed reference points for said helmet.

2. An apparatus according to claim 1 wherein the first plurality is fixed to the helmet.

3. An apparatus according to claim 1 or 2 wherein each light source emits a beam of light uniquely identifiable from the other light sources.

4. An apparatus according to claim 3 which comprises means for modulating the beams of light emitted by the light sources.

5. An apparatus according to claim 4 wherein the relating means comprises filter means for discriminating between modulated signals received from said direction-of-arrival sensors.

6. An apparatus according to any of claims 1 to 5 which comprises at least three light sources and at least two optical sensors.

7. An apparatus according to any of claims 1 to 6 wherein the light sources are light-emitting diodes.

8. An apparatus according to any of claims 1 to 7 wherein each direction-of-arrival sensor comprises a mirror-cube

type sensor.

9. A helmet pointing apparatus substantially as herein described with reference to the accompanying drawing.